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ciate professor of geography in the University of Sydney.

## DISCUSSION AND CORRESPONDENCE

### VISIBLE SOUND WAVES

THE following notes, written by Lieutenant Thomas T. Mackie, 123d Field Artillery, A. E. F., describe a phenomenon which must have been observed rarely, if ever before, and it seems to be very much worth while to put the circumstances on record.

On one or two occasions within recent years the occurrence of sound waves visible to the naked eye under peculiar atmospheric conditions has, I believe, been reported; yet the event is so unusual that I have been persuaded to describe a similar one which I witnessed at the front on the opening day of the Meuse-Argonne offensive.

During the days immediately preceding the attack my regiment moved into position in a wooded area opposite Montfaucon, characterized by the roughness of the terrain, a jumble of high hills cut up by narrow and deep valleys. The battery to which I belonged was sent into position at the head of one of these valleys, enclosed by very steep slopes, and having roughly the shape of a V with the open end to the south. Some four or five hundred yards to our rear and approximately on a line with the extremities of the arms of the V was a battery of six-inch rifles.

For several days the weather had been more or less rainy and wet, and the morning of September 26 found us covered by a very heavy bank of fog which entirely excluded the sun. Soon after the attack opened, I had occasion to go to the top of one of the hills which flanked our position, and at a certain definite level above the battery a very considerable disturbance in the fog was noticeable after each discharge of the heavy rifles behind me. The visibility was such that the flash of the discharge could not be seen, but each time before the report reached us a band of greater density was clearly visible in the fog, moving with great rapidity up the valley toward us in the form of an arc. Its arrival was simultaneous with that of the sound of the discharge. This arc of greater fog density was perhaps six feet from its anterior to its posterior edge, and of about the same depth. It followed closely an altitude of some sixty or seventy feet above the floor of the valley and was clearly visible from both above and below that plane, but no similar phenomena were visible in any other plane.

The recent researches of Professor D. C. Miller, and others have shown that the muzzle wave from a large gun carries in its front a narrow region of compression immediately followed by a relatively wide region of expansion. From the above account, it would appear that the air was saturated with water vapor at a particular level, and that the expansion in the wave produced a visible increase in the fog density, the effect disappearing immediately again, owing to the subsequent re-evaporation when the air regained its normal pressure and temperature. The conditions of the terrain were very favorable to the concentration of a great amount of energy into the wave-front, and this was probably assisted by a sound-mirage effect. The upper layers of air being warmer than the lower the sound wave-fronts would be so bent as to tend to keep the energy near the earth's surface. The "experiment" was thus being conducted under such circumstances and on such a scale as can not readily be reproduced in the laboratory, and would rarely occur anywhere.

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## DRIFT BOTTLES AS INDICATING A SUPERFICIAL CIRCULATION IN THE GULF OF MAINE

IN his "Explorations in the Gulf of Maine" H. B. Bigelow<sup>1</sup> has found evidence of a circulation of the water in the gulf. Since this evidence depends chiefly on the contours of the osohalines and the distribution of plankton, the direction and rate of movement of the drift bottles to be described, obtained incidentally in another investigation may be of importance in adding to this evidence. During the summer of 1919 as part of the hydrographic work in the Bay of Fundy by the Biological Board of Canada, 330 drift bottles were set out in the bay. Sixteen of these bottles have been picked up on the shores of the Gulf of Maine. The

<sup>1</sup> *Bull. Mus. Comp. Zool.*, Vol. 58, p. 29; Vol. 59, p. 149; Vol. 61, p. 163